



EUI WORKING PAPERS IN ECONOMICS

EUI Working Paper ECO No. 95/35

On the Detection of Collusion and Predation

LOUIS PHILIPS

WP
330
EUR

European University Institute, Florence

EUROPEAN UNIVERSITY INSTITUTE



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ECONOMICS DEPARTMENT

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Printed in Italy in November 1995
European University Institute
Badia Fiesolana
I – 50016 San Domenico (FI)
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Presidential Address to the Annual Congress
of the European Economic Association, Prague, September 1995

ON THE DETECTION OF
COLLUSION AND PREDATION

by
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Abstract

This lecture not only shows how game theory can contribute to the detection of collusion and predation, but also how experts for the defense can use game-theoretic arguments to make such detection difficult. A few important European anti-trust cases are discussed to illustrate.

Keywords: Competition policy; game theory

JEL classification: L40, L41, D43.

I. Introduction

Let me start with a quotation from the Bible: *"And Moses went down from the mount unto the people, and sanctified the people; and they washed their clothes. And he said unto the people, "Be ready against the third day: come not at your wives"*.

This quotation seems appropriate, not because this congress is lasting three days, but because - like Moses - I shall come down from the mountain and bring you the tables with the commandments. This will be my gift to those of you who are or will be involved in the implementation of competition policy at the European or national level. If those working for the defense, the so-called expert witnesses, obey the ten commandments, they will make the detection of collusion even more difficult than it is today. Yet, if the antitrust authorities know the ten rules of the game the defense is playing, they will react better than they currently do and increase their chances of detecting collusion.

In plain words, my topic is about how game theory can help collusion detection and especially about how game theory can help in making collusion detection difficult. Indeed, since we, the economic experts, are more often than not paid to testify for the defense, I shall pay special attention to the arguments they need to make their case.

It should be clear, therefore, that I shall disappoint those of you who expected me to enumerate all the weaknesses of the current use or misuse of game theory in industrial economics, as well as those of you who thought I would give my views on how competition policy ought to be conceived in the light of current developments of microeconomic theory. I shall resist the first temptation, because I am too young to get involved in methodological

issues. I shall resist the second temptation, because as a fully trained lawyer I must take the legal framework within which competition policy is operating in Europe as given. This view may seem old-fashioned in view of the current legal doctrine, but I am too old to change my legal instincts.

So let me start by briefly reminding you of this legal framework as formulated in Article 85 and Article 86 of the Treaty of Rome and in most national legislations (which are, today, directly inspired by these articles).

First of all, cartels, price agreements and market separating agreements are illegal and therefore not enforceable. I call these examples of explicit collusion.

Second, tacit collusion is also illegal. Tacit collusion refers to collusive outcomes that are sustained as equilibria of a noncooperative repeated game. Article 85 calls these "concerted practices", that is, collusive outcomes based on a "concordance of wills" in the absence of explicit agreements. There may have been pre-play communication, but certainly no communication during the play. This, I understand, distinguishes European competition policy from US antitrust law.

Third, according to Article 86, the abuse of a dominant position, not the dominant position as such, is illegal. The abuse can take any form.

A few general comments seem to be in order at this point. In this legal framework, antitrust authorities are not social planners. The objective of European competition policy cannot be construed as getting price down to marginal cost or maximising social welfare. So the theorems of welfare economics are not to be applied per se. (Please interpret this as a statement of fact rather than a methodological statement).

Also note that I defined tacit collusion in terms of market outcomes rather than conduct. I suspect that antitrust lawyers may have difficulties with this, given that they are used to trying to give proof of anticompetitive behaviour. Their hesitations may also be due to the fact that economics, and especially game theory, comes in when one has to define and measure market outcomes.

Finally, let me mention that cartel laws, such as the ones just described, are good not only for consumers but also for business, as Selten (1984) has shown. The intuition behind this result is that collusive profits are likely to attract new entry. When collusion is effectively prevented by cartel laws, there are fewer competitors around. More precisely, the maximal number of entrants compatible with non-negative noncollusive Cournot profits is smaller than the number of entrants in a collusive game. As a consequence, the expected sum of all profits in an industry and the expected profit per producer is larger when cartel laws are enforced.

A natural way to proceed is to discuss first the enforcement of Article 85, with special emphasis on the detection of tacit collusion since that is the main problem antitrust authorities are facing today, and then to consider the detection of abuses of dominant positions.

II. Enforcement of Article 85

2.1. Explicit Collusion

In the early days, some 30 years ago, the first task of DG IV, the Directorate General of the Commission in charge of competition policy, was to detect explicit collusion. In those days, it was said that one should watch

markets in which competitors are "few". The reason was a simple one - and a wrong one: the more competitors there are, the more difficult it is to agree. In addition, nobody knew what "few" meant. Today we know how many "few" are. Selten (1973) gave the answer, an amazingly precise one: "4 are few and 6 are many". If there are 4 or less competitors, the probability of finding a cartel is 1. If there are 5, the probability that all 5 will collude is 0.221. If there are more than 5, this probability is 1% or less.

Why is this? Because if there are less than 5 competitors in a market, they will all find it profitable to collude. If there are more than 5, it becomes more advantageous to stay out of a cartel formed by others, that is, the position of an outsider becomes relatively more attractive as the number of competitors increases.

The argument hinges on the number of firms that find it profitable to stay out of a collusive agreement. Let k be this number and let n be the number of competitors in a market. Let these n players play a 3-stage game in which they decide to participate in a collusive agreement or not in the first stage. In the second stage, those who decided to participate agree on a quota cartel, and finally all decide how much to supply in a third Cournot subgame.

Up to $n = 4$, for all of them to participate, or $k = 0$, is a subgame perfect equilibrium. When there are more than 4 firms, cartel equilibria with less than n firms participating can be found. However, if the number of non-participants is $k \geq (n - 1)/2$, then every player receives the unrestricted Cournot-Nash equilibrium profit. In other words, it then doesn't make sense to set up a cartel because the participators will behave

like the non-participants. So, for a cartel to be effective, we must have $k < (n-1)/2$. This means that in a market with 5 or 6 competitors, an effective cartel has 4 members. With 7 or 8 competitors, the cartel will have 5 members, and so on.

How general is this result? I think it is quite general. The assumptions made, such as linearity and symmetry, are simplifying assumptions and are not really restrictive. The only potential problem is that, in Selten's game, the players have complete information. Is it still true that "4 is few and 6 are many" when firms have private information about their costs and are not symmetric? The surprising answer is: yes! Truthful cost reporting, that is, incentive compatibility, combined with efficiency is enforceable only up to $n = 4$. This is the important result obtained by Cramton and Palfrey (1990).

2.2. Tacit Collusion

When the legal advisors of cartel members discovered that Article 85 had to be taken seriously, they had their clients throw their agreements in the waste basket. Simultaneously, the attention of DG IV shifted to the detection of tacit collusion, on the assumption that explicit collusion was being replaced by tacit collusion. Inevitably, DG IV began to discover the ubiquity of oligopolistic situations, characterised by strategic interdependence, and the irrelevance of the pure competition model.

A theory of oligopoly was needed. However, in the absence of a well developed game-theoretic approach in the sixties, all microeconomic theory had to offer was what I would call the Stigler approach. George Stigler's 1964 paper on "A Theory of Oligopoly" indeed provided the dominant frame of reference, in Europe as well as in the United States. In today's

game-theoretic jargon, it appears as a model in which oligopolists play a "one-shot game" with two strategies: either cooperate to fix prices or deviate by cheating. In Jonathan Baker's (1993, p. 151) words:

"Indeed, the unilateral incentive to deviate on a cooperative arrangement to fix price, highlighted by Stigler, is the very market force by which competition insures low prices and high output to the benefit of consumers and the economy".

To put it sharply, cheating became synonymous with competitive behaviour. Anything that makes it difficult for an individual firm to cheat, such as information sharing or actual punishments, was used as proof of tacit collusion. In fact, antitrust authorities spent a lot of time trying to collect evidence of direct communication between competitors, threats of punishment or actual punishments of deviators.

The difficulty with this approach is that, when no cheating and therefore no punishment is observed, there is no way to distinguish tacit collusion from strategic interdependence. The concept of a noncooperative Nash equilibrium, from which nobody wishes to deviate, but in which a collusive as well as a noncollusive outcome can be sustained, was missing. To construe the absence of cheating as evidence of tacit collusion is no longer acceptable.

Today's insights derived from the theory of repeated games, initiated by Jim Friedman in 1971 and further developed as different versions of the so-called Folk Theorem, underpin a new approach to the detection of tacit collusion. Experts for the defense are likely to find strong arguments in what I am going to say and will force the antitrust authorities to rethink their approach. While many game theorists find the Folk Theorem deceptive,

because it shows that many more or less collusive equilibria can result from repeated noncooperative play when deviations can be punished in a credible way, I find the theorem very useful from the point of view of competition enforcers. Indeed, it should make them understand that a) collusive outcomes are possible without there being anticompetitive conduct, b) to that extent, there may be no need for firms to even try to make secret agreements, whether written or oral, c) it may be a waste of time to look for evidence on attempts to collude or attempts to punish cheaters, and d) when the Folk Theorem is in operation, antitrust proceedings will have to concentrate more and more on assessments of market outcomes, that is, the more or less collusive or non-collusive nature of noncooperative equilibria. In one word, industry behaviour can no longer be understood as emerging from the one-shot game proposed by Stigler but has to be seen as emerging from a repeated game (Baker, 1993, p. 153).

This reasoning leads me to a stylised description of future antitrust proceedings in the following terms. On the one hand, the economic expert speaking for the defense (in a case where firms are accused of concerted practices) has to be able to argue (and will be paid exactly to this effect) that the observed prices, sales and profits are typical for a noncollusive equilibrium sustained in a noncooperative repeated game. In the absence of direct evidence of collusion (no written agreements were discovered, there are no tapes recording secret conversations), the antitrust authority, on the other hand, has to put forward (and to pay) an economic expert that contradicts the expert for the defense and is trying to show that the prices, sales and profits observed are collusive equilibria sustained in a noncooperative repeated game.

A natural starting point for these experts is to postulate the existence of demand and cost functions and to start talking about the parameters of these functions. This, then, raises the question to what extent these parameters are known and by whom. At this point, it seems to me that the economists working for the antitrust authority are in a more difficult position than the economists working for the defense. They are at an informational disadvantage, for the simple reason that they have to get the relevant numbers from the firms that are under attack.

Given this informational disadvantage - which I think is very real - I wish to argue that the defense can make proof of collusion very difficult, to the extent that it can make the collusive outcome of the game indistinguishable from the noncollusive one. I am referring here to joint work with Ronald Harstad. We call this immodestly our "indistinguishability theorem".

The simplest way to explain it is to do the following numerical exercise. Let there be a market with n competitors selling a homogeneous product. The antitrust authority knows that they all produce at the same marginal cost c and the numerical value of c , which was truthfully reported. The authority also knows that their market demand is linear and that its intercept shifts from season to season. However, the authority does not know the numerical value of these intercepts. But it observes the time path of the price per season, since this is reported in the specialised press. The problem is to figure out whether the observed price, p_s , for season s , is the result of a Cournot-Nash equilibrium - in which case there is no collusion - or the result of, say, joint profit maximisation. I suppose joint profit maximisation to simplify the presentation, it being understood that the

repeated game could have many other collusive outcomes with profits below the monopoly level.

In a Cournot-Nash equilibrium the price is

$$p_s^c = \frac{a_s + nc}{(n+1)} \quad (1)$$

where a_s is the unknown demand intercept for season s . With

$$n = 3$$

$$c = 10$$

$$a_s = 14$$

we obtain

$$p_s^c = \frac{14 + 3(10)}{4} = \frac{44}{4} = 11.$$

In a collusive outcome with joint profit maximisation, the price in season s is

$$p_s^M = \frac{a_s + c}{2} \quad (2)$$

or, using the same parameter values,

$$p_s^M = \frac{14 + 10}{2} = \frac{24}{2} = 12.$$

Suppose that the observed price is actually 12, and that these 3 firms were tacitly colluding. What should the economic expert for the defense do? He or she should convince the authority that 12 is a Cournot-Nash equilibrium price. That is easy enough. Put (1) equal to (2) and solve for \hat{a}_s , the false intercept to report:

$$\frac{\hat{a}_s + nc}{(n+1)} = \frac{a_s + c}{2}$$

or

$$\begin{aligned}\hat{a}_s &= \frac{1}{2}[a_s(n+1) - c(n-1)] \\ &= \frac{1}{2}[14(4) - 10(2)] = \frac{1}{2}(56 - 20) = \underline{18}.\end{aligned}$$

Overemphasising the level of market demand does the trick: pretend that a_s is 18 rather than 14. Indeed, using $\hat{a}_s = 18$ in the Cournot-Nash solution (1) gives

$$\frac{18 + 3(10)}{4} = \frac{48}{4} = 12.$$

The observed price appears as competitive. In this sense, the two games cannot be distinguished.

Note that demand shocks, that is, changes in a_s , should be exaggerated also: always emphasise seasonalities! Needless to say, the same exercise can be done when the authority lacks information about other parameters, say marginal cost. Then the defense should exaggerate the level of costs but under-report cost changes.

The intuition behind the indistinguishability theorem should be clear. It goes back to Bentley MacLeod's remark in his 1985 European Economic Review paper on "conscious parallelism": as long as the profit functions are not known, there are no systematic differences between the size of price responses to exogenous shocks at the noncollusive and collusive equilibria. Clearly, this basic wisdom was ignored in the famous Wood Pulp decision. On 19 December 1984, the Commission decided that several North American, Finnish and Swedish producers who imported wood pulp into Europe (to be used by the paper industry) had to pay fines ranging between 50,000 and 500,000 ECU, because they had announced and enforced parallel seasonal price changes. In 1993, the European Court of Justice annulled the

decision and most of the fines for lack of proof. Indeed, the Commission had looked only for evidence of direct communication and used the absence of deviations from the parallel time path as evidence of collusion. Before the Court, the concept of a Cournot-Nash equilibrium was mentioned by the Advocate-General. But it was not used in the reasoning of the Court, nor was the concept of a repeated game. At any rate, I am very pleased with this judgement.

The indistinguishability theorem can also be illustrated in terms of price strategies instead of quantity strategies (see Böhnlein, 1994). Consider the ICI-Solvay decision of 1990. ICI was selling soda ash, a raw material used in the glass manufacturing industry, in the UK and Ireland. Solvay, the largest producer of soda ash, was selling in continental Europe. Several cartel agreements dating back to the last century had assigned continental Europe to Solvay while ICI had agreed to restrict its activity to the British Commonwealth. In 1972, the last of these explicit agreements was terminated. Yet, both firms continued to serve their former markets. During the eighties, UK prices rose by about 15 to 20 percent above those of continental Europe, more than the cost of shipping soda ash across the Channel. The Commission used the fact that neither ICI nor Solvay invaded each other's market during this decennium as proof of tacit collusion.

Again, the absence of market penetration can be rationalised as a feature of the noncollusive Nash equilibrium of a stage game in a repeated game. Suppose each producer sets a national limit price equal to the marginal cost of serving customers in the home market plus shipping costs across the Channel: market penetration is not profitable. Then equate this competitive price with the monopoly price in each producer's national market, equal to the national demand intercept + marginal cost divided by 2.

Now the expert for the defense has three parameters with which to play in order to make the absence of market penetration appear as a competitive equilibrium. He or she should obviously exaggerate the intercept of the national demand curve or the level of the firm-specific production costs, as in the previous example with Cournot strategies. However, I recommend an exaggeration of the transportation costs, especially the shipping costs across the Channel, since these are subject to considerable economies of scale so that they depend on the market share that could be captured in the foreign market. Since both firms do not actually enter the foreign market, there is no available data on the entrant's potential market share.

Note that the expert for the prosecution was in a somewhat stronger position in the ICI-Solvay case than in the Wood Pulp case. He or she could have convincingly argued that the price gap between the UK and the Continent was collusive by proving that the two competitors had the same production costs, the same delivery costs and the same shipping costs over the Channel. Then the limit prices would have been the same in the two markets and any price difference would have been proof of collusion. An additional argument was to show that the intercepts of the market demand curves differed a lot while the costs did not since these intercepts show up in the monopoly prices only. To my knowledge, none of these questions were seriously discussed before the Commission reached its conclusion.

These two examples indicate that the indistinguishability I am talking about is not to be interpreted as a classic identification problem, as encountered in econometrics. The industrial economists among you know how identification can be obtained in the measurement of market power, as exemplified by the work of Bresnahan (1989). However, the problem there is to measure departures from perfectly competitive behaviour. Here the

problem is to distinguish two different equilibria. A correct econometric approach can be found in Margaret Slade's (1987) well known work on tacit collusion among gasoline stations in Vancouver. She was able to estimate demand, cost and reaction functions and thus to compare collusive and noncollusive outcomes of the stage game with the actual observed outcome of the repeated game. Note, however, that she benefited from most favourable circumstances, which are not likely to be present in an antitrust proceeding. First, a price war was actually going on, with price changes occurring often within a day, so that the data displayed an exceptional variability. Second, the variable cost of a gasoline station is simply the wholesale price of gasoline, which was also highly variable. Third, Slade was able to collect prices, costs and sales on the spot, day by day, until the price war stopped. Finally, the price war was typically an information-gathering device about the new level of demand after a demand shock had occurred. A comparable variability and reliability of the data is not likely to be available in antitrust proceedings.

It would therefore be nice if a simple test, involving a back-of-the-envelope calculation on indisputable data and based on a theoretically solid analysis, was available. I am glad to report that such a test can indeed be derived from the Bertrand-Edgeworth price-setting duopoly game with given capacities as formalised by Kreps and Scheinkman (1983). The test itself is due to Osborne and Pitchik (1987). Let one duopolist have a larger capacity than the other and let these capacities be determined noncooperatively in a first stage. In a second stage of the game, the duopolists collude. (This is a case of so-called "semicollusion"). If the cost of capacity is below some limit, the collusive equilibrium implies excess capacity in the industry, in the sense that the sum of the two capacities

exceeds the total sales that yield the unconstrained monopoly profit. The duopolists plan their capacities in such a way that part of their capacities is not going to be used for production. In such an equilibrium, the profits are not proportional to the capacities, so that the profits per unit of capacity differ between the two competitors. In fact, Osborne and Pitchik show that a) it is the firm with the smaller capacity that makes the higher profit per unit of capacity and b) this profit increases relative to that of the large firm when their joint capacity increases relative to market demand. In the absence of collusion, however, the corresponding Kreps-Scheinkman equilibria imply unit profits that are the same.

In his recent paper on the great salt duopoly, Ray Rees (1993) tried to show that the two British producers of white salt replaced their explicit price agreement, that was discontinued in 1956 after the passing of the Restrictive Practices Act in the UK, by tacit collusion. He used a version of the Folk Theorem to show that none of the duopolists had an interest in deviating from parallel pricing, given a particular type of punishment.¹ The immediate objection is that this is not really proof of collusion: if parallel pricing is an implication of a noncollusive Nash equilibrium, there is no incentive to deviate either. The Osborne-Pitchik detector, to the contrary, derives from a direct comparison between a collusive and a non-collusive Nash equilibrium. Throughout the period under investigation (1980-1984), both British Salt (BS) and ICI Weston Point (WP) had excess capacity. BS had a given capacity of 824 kilotonnes, WP had a given capacity of 1095

¹ In the unpublished 1991 version of his paper, Rees postulates mutual minimaxing as in Fudenberg and Maskin (1986). In the published 1993 version, the duopolists are supposed to use the simple penal code defined by Lambson (1987).

kilotonnes. All I had to do was to divide the yearly profits by the capacities and to divide the sum of the capacities by total sales, to find the numbers given in Table 1.

Table 1: The Great Salt Duopoly

	1980	1981	1982	1983	1984
BS profit	7065	7622	10489	10150	10882
WP profit	7273	7527	6841	6297	6204
Bs profit per unit of capacity	8.6	9.3	12.7	12.3	13.2
WP profit per unit of capacity	6.6	6.9	6.3	5.8	5.7
industry capacity/total UK sales	1.5	1.7	1.7	1.9.	1.9

Not only was BS's profit per unit of capacity larger than WP's: it also increased relative to WP's as their joint capacity increased relative to market demand. None of these numbers is disputable (except for errors in my divisions). This test beats the indistinguishability theorem: I wish more such tests were available.

III. Enforcement of Article 86

I now turn to the enforcement of Article 86, which condemns abuses of a dominant position. Note that market dominance, or more generally market power as such, are not under attack. I wish to concentrate on the detection of one form of abuse, namely predatory pricing. Strangely enough, predatory pricing is not on the list of examples given by the Treaty of Rome (which refers to unfair prices, restriction of production,

discrimination and tying) and was not part of the vocabulary of DG IV until the defense in the AKZO case argued that its client, AKZO, was not guilty of predation - something DG IV had never claimed it was guilty of!

We know, since the publication of Selten's Chainstore Paradox, in 1978, how difficult it is to explain the occurrence of predation theoretically. We also know, since Isaac and Smith's (1985) experiment, how difficult it is to see it happen in the laboratory: we had to wait until the experiment by Jung, Kagel and Levin, published only last year, where incomplete information about the incumbent's type was introduced in a form that is compatible with the Kreps-Wilson (1982) model.

My concern, today, is with the detection of predation in practice. As with tacit collusion, I wish to argue that a good detector requires good game-theoretic modelling. My approach is to define predation as a pricing policy that turns a profitable entry opportunity for an entrant into an unprofitable one. To discover whether such an opportunity exists, that is, whether there is room for an additional firm in a market, it is necessary to find out whether the entrant would make a profit in a noncooperative post-entry Nash equilibrium. It is only if the entrant could have made profits that predation can be claimed. Typical for my approach is the focus on the entrant's profits, to check whether these could be positive in the circumstances under investigation. This seems to be a new idea, to the extent that the conventional approach in antitrust proceedings concentrates attention on whether the incumbent is pricing below cost. (Antitrust authorities are used to taking a close look at the incumbent's costs, not at the entrant's!). Once it is established that the entrant could have made profits in equilibrium, it remains to show, needless to say, that the losses incurred result from being

preyed upon and not from the entrant's mistakes or his aggressive behaviour in establishing leadership, that is, Stackelberg warfare.

To illustrate, let me first take the example of the "bus wars" in the U.K. In 1986, local bus services were deregulated, so that local bus operators were free to operate commercial services on any route in town, including routes served by municipally-owned public bus companies which operated traditional double-deckers. In many towns, private firms came in with frequent minibus services on the main routes through the city centres. The local incumbents reacted by reducing their fares and drastically increasing the bus-miles operated.

In Inverness, a town in the Scottish Highlands, an entrant started 8 minibus routes in May 1988. In August it expanded with a further 7 minibus routes. In March 1989 it went bankrupt and was taken over. In September 1991, the local incumbent, HSO (Highland Scottish Omnibuses) withdrew from the town. The U.K. Office of Fair Trading referred the case to the Monopolies and Mergers Commission on the grounds that the incumbent (HSO) had restricted the entrant's ability to compete, since it, the incumbent, had not earned enough revenue to cover total costs. The Monopolies and Mergers Commission (1990, p. 1) agreed with this reasoning and concluded that HSO "went too far: its provision of new services and duplicates was grossly excessive, incurring losses that were unjustified....".

In an impressive paper published in 1993 in the Journal of Transport Economics and Policy, Dodgson, Katsoulacos and Newton made a careful analysis of the case and compared the actual losses of the incumbent and the entrant with their Nash equilibrium profits. The situation one month after entry is depicted in Figure 1. Point A represents the losses made by both firms. Point E represents the positive Nash equilibrium profits, indicating

that there was room in the market for two firms. Figure 2 shows that the same was true a year later but that the Nash equilibrium had become more asymmetric. This is consistent with there being predation.

However, these losses were avoidable. Look at the reaction curves in Figure 3, where the numbers on the axes represent 10,000 bus-miles. The curves intersect at the point where the incumbent operates 25,000 bus-miles and the entrant 7,000 miles. In fact, they operated 72,000 and 48,000 bus-miles respectively, as shown by point A. This point lies above the line BB' , at which the incumbent makes zero profit ($\Pi_m = 0$). The entrant entered with a level of output which was not only excessive but so high as to deny the incumbent the possibility of a profitable response. During subsequent periods, both firms continued to increase their bus-miles: this is clearly a case of Stackelberg warfare, both fighters trying to secure a leadership position in the future.

This fascinating episode has shown that a competitive battle can be (and is easily) misinterpreted as predation. The time has come to draw the lesson: a plaintiff (the entrant) in a case of alleged predation can easily make a fight by the incumbent price leader appear as predatory behaviour. Conversely, the defense (the incumbent) can make predatory prices appear as noncooperative Cournot-Nash outcomes that are not objectionable. Is this the Harstad-Phlips indistinguishability theorem again? Yes, it is.

In such a case of alleged predation, the incumbent is in the defense. So one possibility for the defense is to argue that the observed prices and quantities result from a Cournot-Nash equilibrium of the stage game rather than from predatory behaviour. To see what sort of advice to give, the expert for the defense could do the following exercise (see Normann, 1994). First compute the usual first-order conditions for a Cournot-Nash

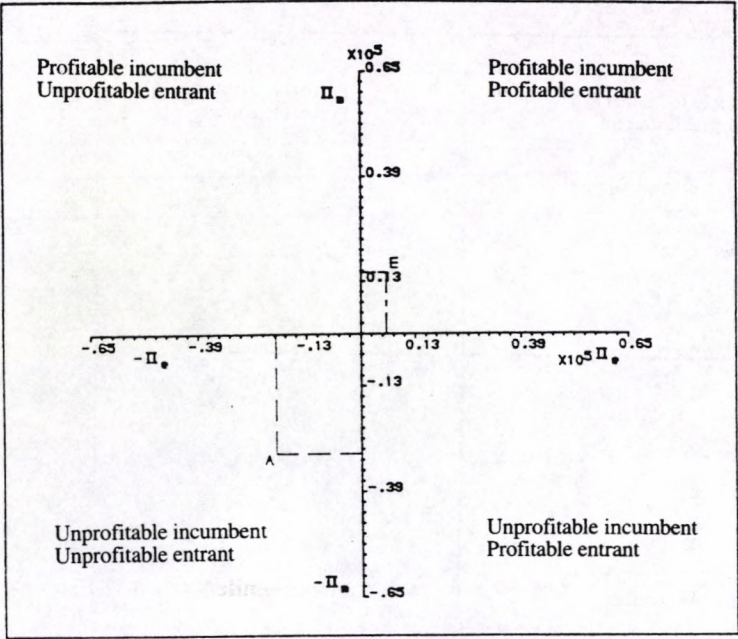


Figure 1: Actual and Nash equilibrium profits in Inverness one month after entry

Key: Π_m : Incumbent's profit; Π_e : Entrant's profit; A: Actual; E: Estimated

Source: Dodgson et al. (1993, Figure 2).

Data

	Actual Outcome (A)		Nash Equilibrium (E)	
	Incumbent HSO	Entrant ITL	Incumbent HSO	Entrant ITL
Fare (pence)	25.5	25.5	50.9	50.9
Bus-miles	72,000	48,000	25,000	7,000
Patronage	199,000	82,000	104,000	23,000
Profit/loss (£)	-30,000	-20,000	+16,000	+4,000

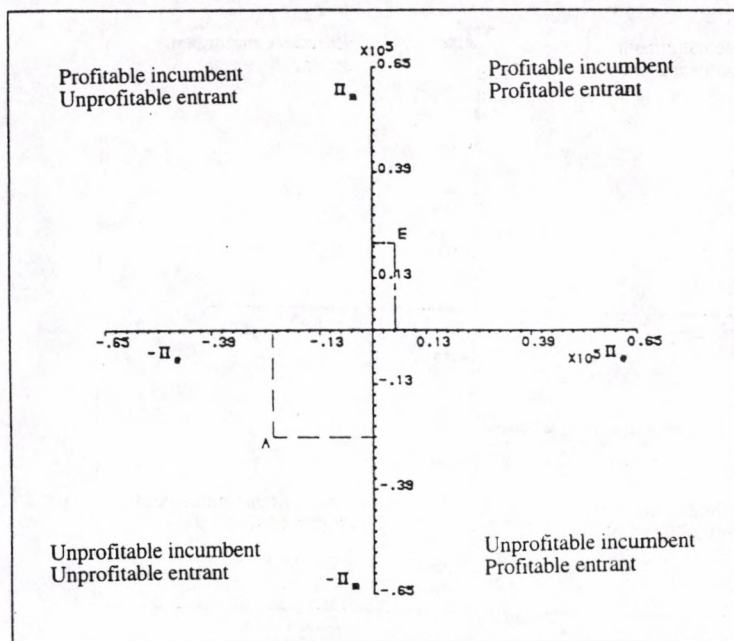


Figure 2 : Actual and Nash equilibrium profits in Inverness one year after entry

Key: Π_m : Incumbent's profit; Π_e : Entrant's profit; A: Actual; E: Estimated

Source: Dodgson *et al.* (1993, Figure 3).

Data

	Actual Outcome (A)		Nash Equilibrium (E)	
	Incumbent HSO	Entrant ITL	Incumbent HSO	Entrant ITL
Fare (pence)	27.7	27.7	47.3	47.3
Bus-miles	102,000	72,000	38,000	10,000
Patronage	227,000	113,000	137,000	38,000
Profit/loss (£)	-26,000	-24,000	+24,000	+7,000

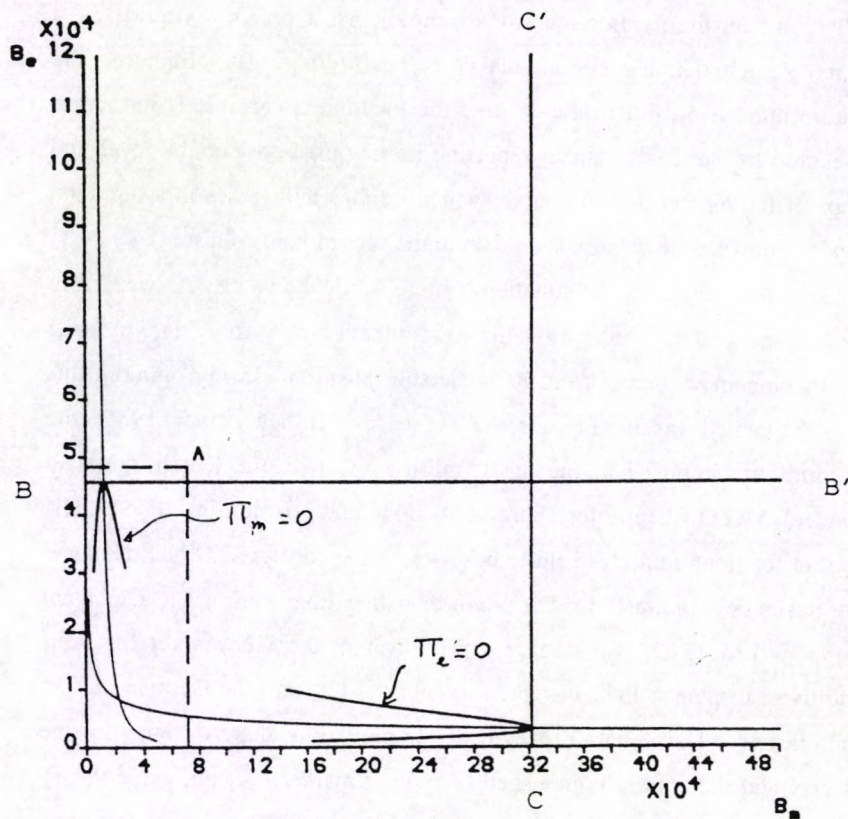


Figure 3 : Bus-miles reaction curves in Inverness one month after entry

Key: Π_m : Incumbent's profit; Π_e : Entrant's profit; A: Actual;

B_m : Incumbent's bus-miles; B_e : Entrant's bus-miles

Source: Dodgson et al. (1993, Figure 4).

equilibrium. Then compute the first-order conditions describing predatory behaviour, on the assumption (for example) that a predator would sell a quantity such that the entrant makes at best zero profit. Equating the equilibrium quantities, it is clear that the incumbent can justify his larger sales and low prices by under-reporting its marginal cost or the level and slope of the market demand curve (which implies telling lies in a direction opposite to what the defense should do in the case of tacit collusion).

In real life cases, the situation is more subtle, however. As we saw in the Inverness bus war, it is often the entrant that engages in warfare to make the incumbent withdraw from its leadership position. In my opinion, this also happened in the famous AKZO case. In December 1985, the Commission imposed a fine of 10 million ECU on the Dutch chemical concern AKZO Chemie for abuse of its dominant position in the local UK market for flour additives sold to bakeries. Allegedly, AKZO had damaged the business of a small British producer called Engineering and Chemical Supplies Ltd. (ECS) by starting a price war in the UK market for flour additives, to punish ECS for entering both the UK and the German market for plastics. The situation is typical for predation: there is entry in one market and the entrant is punished in another market. Again, game theory tells us which questions should have been asked and which answers given.

First, the Commission used as evidence the fact that the managers of AKZO had formulated threats that, unless ECS withdrew from the plastics market, retaliation from AKZO would follow in the market for flour additives. One AKZO manager mentioned not only overall price reductions but also selective price cuts aimed at particular customers of ECS. The problem is whether such threats are credible, knowing that both firms had a long history of friendly collaboration and were perfectly informed about

each other. During the proceedings, this question of credibility was not even raised.

Second, shortly after the threats had been formulated, AKZO made a binding commitment to eliminate predation from its action set, thus indicating that it was willing to collaborate. Since ECS had been a price follower for a decade, AKZO could expect ECS to continue to follow. Yet, when AKZO announced the usual price increase in the following year, ECS did not follow and made offers to AKZO's customers at the old price. The Commission did not interpret this as an attack. But when AKZO did counter-attack, in late 1980, that was interpreted as an abuse of a dominant position.

Third, when ECS argued that it had lost business, the Commission looked at AKZO's costs of production, not at those of ECS! AKZO appealed before the European Court of Justice, where the Advocate-General suggested that the Court should have a look at the entrant's cost of entry and cost of production. Amazingly, the Court decided, in 1991, that an analysis of ECS's cost structure is irrelevant. All it wanted to find out was whether AKZO had priced below cost.

Fourth, and last, suppose the Court had accepted to look into ECS's cost structure. What should its economic expert have done? The indistinguishability theorem suggests again that he or she should have urged ECS to overstate its costs of production as well as its cost of entry.

On the third day, Moses went up the mountain again: "*there were thunders and lightnings, and a thick cloud upon the mount, and the voice of the trumpet exceedingly loud;...*". When he came down, he was carrying the tables with the 10 commandments. Let me follow this illustrious example

and bring you the 10 commandments which summarise the advice I'd like to give the economic experts for the defense:

THE TEN COMMANDMENTS

1. *Thou shalt have no other gods before competition*
2. *Thou shalt exaggerate the level of demand*
3. *Thou shalt exaggerate demand shocks*
4. *Thou shalt exaggerate the inelasticity of demand*
5. *Thou shalt exaggerate the level of costs*
6. *Thou shalt under-report cost shocks*
7. *Thou shalt exaggerate asymmetries between firms*
8. *Thou shalt exaggerate asymmetries between markets*
9. *Thou shalt exaggerate costs of transportation*
10. *Thou shalt otherwise tell the truth.*

REFERENCES

- BAKER J.B. (1993), "Two Sherman Act section 1 dilemmas: parallel pricing, the oligopoly problem, and contemporary economic theory", Antitrust Bulletin, spring, 143-219.
- BÖHNLEIN B. (1994), "The soda-ash market in Europe: multi-market contact with collusive and competitive equilibria", EUI Working Paper ECO no. 94/42, Florence.
- BRESNAHAN T.F. (1989), "Empirical studies of industries with market power", in SCHMALENSEE R. and R. WILLIG (eds.), Handbook of Industrial Organization, vol. II, Amsterdam, North-Holland, ch. 17.

- CRAMTON, P.C. and T.R. PALFREY (1990), "Cartel enforcement with uncertainty about costs", International Economic Review, 31, 17-47.
- DODGSON J.S., KATSOUALACOS Y. and C.R. NEWTON (1993), "An application of the economic modelling approach to the investigation of predation", Journal of Transport Economics and Policy, 153-170.
- FRIEDMAN J.W. (1971), "A non-cooperative equilibrium for supergames", Review of Economic Studies, 38, 1-12.
- FUDENBERG D. and E. MASKIN (1986), "The folk theorem in repeated games with discounting or with incomplete information", Econometrica, 54, 533-554.
- HARSTAD R.M. and L. PHILIPS (1994), "Informational requirements of collusion detection: simple seasonal markets", mimeo, European University Institute, Florence. Reproduced in Philips (1995, ch. 8).
- ISAAC R.M. and V.L. SMITH (1985), "In search of predatory pricing", Journal of Political Economy, 93, 320-345.
- JUNG Y.J., J.H. KAGEL and D. LEVIN (1994), "On the existence of predatory pricing: An experimental study of reputation and entry deterrence in the chain-store game", The Rand Journal of Economics, 25, 72-93.
- KREPS D.M. and J.A. SCHEINKMAN (1983), "Quantity precommitment and Bertrand competition yield Cournot outcomes", Bell Journal of Economics, 14, 326-337.
- KREPS D.M. and R. WILSON (1982), "Reputation and imperfect information", Journal of Economic Theory, 27, 253-79.
- LAMBSON V.E. (1987), "Optimal penal codes in price-setting supergames with capacity constraints", Review of Economic Studies, 54, 385-397.

- NORMANN, H.-T. (1994), "Informational requirements of predation detection", EUI, Department of Economics, Florence, mimeo, reproduced in PHILIPS (1995, ch. 13).
- OSBORNE M.J. and C. PITCHIK (1987), "Cartels, profits and excess capacity", International Economic Review, 28, 413-428.
- PHILIPS L. (1995), Competition Policy: A Game-Theoretic Perspective, Cambridge, Cambridge University Press.
- REES R. (1991), "Collusive equilibrium in the great salt duopoly", mimeo.
- REES R. (1993), "Collusive equilibrium in the great salt duopoly", Economic Journal, 103, 833-848.
- SELTEN R. (1973), "A simple model of imperfect competition where four are few and six are many", International Journal of Game Theory, 2, 141-201, reprinted in R. SELTEN, Models of Strategic Rationality, Kluwer Academic Publishers, 1988, 95-155.
- SELTEN R. (1978), "The chain store paradox", Theory and Decision, 9, 127-159.
- SELTEN R. (1984), "Are cartel laws bad for business?", in HAUPTMAN et al. (eds.), Operations Research and Economic Theory, Springer Verlag, reprinted in R. SELTEN, Models of Strategic Rationality, Kluwer Academic Publishers, 1988, 183-215.
- SLADE M.E. (1987), "Interfirm rivalry in a repeated game: an empirical test of tacit collusion", Journal of Industrial Economics, 35, 499-516.
- STIGLER G.J. (1964), "A theory of oligopoly", Journal of Political Economy, 72, 44-61.



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